



Primary Standards Laboratory Metrology

DC Electrical

Fact sheet

The Primary Standards Laboratory (PSL) maintains a wide variety of primary dc standards to assure accurate and traceable measurements for its customers. Capabilities include voltage, current, resistance, and ratio devices.

The primary dc standards are directly traceable either to the National Institute of Standards and Technology (NIST), to fundamental physical constants, or to self-calibration/ratio techniques. The primary standards include both a laboratory and portable Josephson Array Voltage Standard, a set of Thomas 1-ohm resistors, high-voltage dividers, Hamon transfer standards, and various ratio devices (current comparators, potentiometers, ratio sets, and volt boxes). These standards support a variety of measurement systems, including a teraohmmeter, automated resistance calibration system, shunt calibration system, and intermediate- and high-voltage calibration systems.

Capabilities

Below is a representative sample of our k=2 expanded uncertainties. We are accredited under Lab Code 105002 by the National Institute of Standards and Technology/ National Voluntary Laboratory Accreditation Program (NIST/NVLAP). For details, see <http://ts.nist.gov/ts/htdocs/210/214/1050020.htm>.

•VOLTAGE

J-Volt (10V)	± 0.017 ppm
1.6 V to 1500 V	± 2.5 ppm
1.0 kV to 200 kV	± 140 ppm

•RESISTANCE

Thomas 1 Ω Resistor	± 0.054 ppm
----------------------------	-----------------

•STANDARD RESISTORS

0.0001 Ω to 0.01 Ω	± 11 to 2.5 ppm
0.1 Ω to 10k Ω	± 2 to 0.5 ppm
Special (10 Ω to 10k Ω)	± 0.15 ppm
100k Ω to 1G Ω	± 2 to 16 ppm
10 G Ω to 100T Ω	± 470 to 3300 ppm

•SHUNTS

0.1 A to 2500 A	± 2.5 ppm
-----------------	---------------

•RATIO DEVICES

1:1 to 1:100,000	$\pm 0.5 \times 10^{-7}$
------------------	--------------------------

Major Resources

- DC voltage measurements start with the Josephson Array Voltage Standard that can generate voltages between zero and 10 volts and calibrate Zener voltage standards with an accuracy of better than ± 0.02 ppm at 10 volts.



Josephson Array Voltage Standard

The Zener standards are used in the intermediate voltage system where voltages to 1500 volts are obtained using a special guarded volt box or an automated intermediate voltage system. Precision high-voltage resistors calibrated by NIST are used in a special high-voltage calibration facility with controlled temperature and humidity to extend the range to 200,000 V.



Major Resources (Cont.)

- The standard of resistance is maintained using a group of Thomas $1\ \Omega$ resistors that are calibrated periodically by NIST. The uncertainty assigned to these resistors by NIST is ± 0.05 ppm. Transfer of the ohm to higher and lower resistance values is obtained using resistance ratio devices. Typical uncertainties for resistors are listed under Capabilities. An automated teraohmmeter is used to extend the resistance measurements to $10\text{P}\Omega$ ($10^{16}\ \Omega$).
- A high-current facility is used to calibrate shunts to 2500A using an automated current comparator and a standard resistor. A new, pneumatically actuated, reversing switch improves and simplifies calibrations.
- Ratio devices are self-calibrating, but require stable auxiliary equipment for the calibration process. Standard resistors and various ratio sets, including double-ratio, direct-reading, and universal ratio sets, are used to determine ratio.



1500 VDC Automated Calibration System

Selected Accomplishments

- Development of a portable Josephson Array Voltage Standard jointly with NIST, which is being used to transfer the volt to DOE/NNSA and NASA metrology laboratories.
- Use of new, ultra-high precision, state-of-the-art, automated measurement systems in the areas of voltage, resistance, very high resistance and current, replaced older, manually operated systems.
- Developed automated pressure/vacuum system to measure the pressure coefficient of voltage of solid state voltage standards.
- HV measurement system used to calibrate HV resistors, dividers and power supplies to 200 kV.

Contacts

Warren T. Lewis, P.E.
Sandia National Laboratories
P. O. Box 5800; M/S 0665
Albuquerque, NM 87185
Phone: (505) 284-2119
FAX: (505) 844-4372
Email: wtlewis@sandia.gov

Thomas F. Wunsch, Ph.D.
Sandia National Laboratories
P. O. Box 5800; M/S 0665
Albuquerque, NM 87185
Phone: (505) 844-4359
FAX: (505) 844-4372
Email: tfwunsc@sandia.gov